

X. INDIAN FRESHWATER MOLLUSCS ASSIGNED TO THE GENUS *BITHYNIA*.

By N. ANNANDALE, D.Sc., F.A.S.B., Director, Zoological
Survey of India.

IN Mr. H. B. Preston's volume on the Freshwater Molluscs in the *Fauna of British India* series, eighteen species are assigned to the genus *Bithynia*, Leach (with the two subgenera *Hydrobioides*, Nevill and (?) *Fossarulus*, Neumayr) and several allied forms have since been described from Burma and Assam. All of these (22 species) I have examined, so far at any rate as the shell and operculum are concerned. I find no less than five distinct genera included among Mr. Preston's eighteen species. It is unfortunate that in the official account of an important section of the fauna of India no attempt seems to have been made to examine these species critically. Some of them, probably the majority, must be represented in English collections.

I shall not attempt at present to revise these species, but merely to assign them to their proper genera and sub-genera, to point out the characteristic features of these, and to describe a new genus and a new subgenus that seem to be necessary.

Of the five genera here discussed, four are closely related and must be included in the subfamily Bithyniinae. The fifth, however, which has recently been described by Col. Godwin-Austen, is so distinct that it may be accepted as the type of a new subfamily, the Mysorellinae. The external anatomy of the two subfamilies is identical, but there are important differences in the radula as well as the shell. The subfamilies may be briefly described as follows:—

BITHYNIINAE. Shell never very thick, smooth to the naked eye or with spiral ridges, ovate or globose, with the peristome continuous and the columellar fold ridge-like. Operculum calcareous, concentric or spiral. The central tooth of the radula usually bearing a series of latero-basal denticulations on each side. The external male organ with a well-developed lateral process.

MYSORELLINAE. Shell rather thick, with strong spiral ridges, turbate, with the peristome continuous and prominent. Operculum thick, calcareous, concentric. The central tooth of the radula without latero-basal denticulations but bearing a single downwardly-directed blunt process on either side. The external male organ as in the Bithyniinae.

Key to the Indian Genera, species of which have been assigned to
Bithynia, Leach.

1. Operculum spiral on *both surfaces*, with the nucleus eccentric. Whorls of shell more or less tumid and body-whorl very large; umbilicus closed or rimate; columellar fold ridge-like but by no means prominent; central tooth of radula with latero-basal denticulations in a series on either side *Amnicola*
(*Alocinma*).
2. Operculum concentric, or mainly so externally, with the nucleus central or sub-central, almost smooth internally.
 - A. Shell conspicuously perforate, turbinate, ornamented with strong spiral ridges; peristome continuous, prominent, uniform; central tooth of radula with a single blunt, downwardly-directed lateral process at each side *Mysorella*.¹
 - B. Shell broadly but shallowly umbilicate, with a broad oblique groove proceeding downwards from the umbilicus to the lower margin of the mouth; sculpture consisting of fine spiral grooves; central tooth of radula as in *Amnicola* *Sataria*, nov.
 - C. Shell narrowly umbilicate or subumbilicate, with a narrow groove descending obliquely from umbilicus but not reaching margin of mouth; columellar fold forming a sharp, prominent ridge continuous with outer lip; outer lip hardly thickened; central tooth of radula as in *Amnicola* *Bithynia*.
 - D. Shell resembling that of *Bithynia*, but with the columellar fold greatly thickened and the whole outer lip more or less incrassate; a varix often present on the body-whorl; central tooth of radula as in *Amnicola* *Hydrobioides*.

Two genera in this key (*Mysorella* and *Sataria*) are, so far as we know, monotypic. *Mysorella* has recently been described by Col. Godwin-Austen,² while *Sataria* is here described as new; but the type-species of both have long been known. *Hydrobioides* was first erected as a subgenus of *Bithynia* by the late Mr. G. Nevill.³ I have recently discussed it at some length.⁴ Dr. Baini Prashad⁵ and I have also, still more recently, proposed a new subgenus (*Alocinma*) of *Amnicola*, Gould and Haldeman, to contain certain Indian and Persian species. A large proportion of the Indian species hitherto assigned to *Bithynia* belong to this subgenus, more in fact than can be retained in the former genus. The species described by Mr. Preston, with those recently described by myself, may now be identified generically as follows:—

To the genus *Amnicola* and the subgenus *Alocinma* I attribute the following:—

Bithynia travancorica, Benson; *B. subpulchella*, Nevill; *B. inconspicua*, Dohrn; *B. orcula*, Frauenfeld; *B. laevis*,

¹ Godwin-Austen, *Rec. Ind. Mus.* XVI, p. 431 (1919).

² Godwin-Austen, *Rec. Ind. Mus.* XVI, pp. 211, 431 (1919).

³ Nevill, *Hand List Moll. Ind. Mus.* II, p. 42 (1884).

⁴ Annandale, *Rec. Ind. Mus.* XIV, p. 117 (1918).

⁵ Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 23 (1919).

Morelet; *B. stenothyroides*, Dohrn; *B. dibrugarhensis*, Preston; *Amnicola alticola*, Annandale.

To *Bithynia*, Leach, the following:—

B. tentaculata (Linné), the type-species; *B. ceramcopoma* (Benson); *B. pulchella* (Benson); *B. lutea*, Gray; *B. pygmaea*, Preston; *B. troscheli* (Paasch).

To *Hydrobioides*, Nevill:—

B. turrita, Blanford, the type-species; *B. nassa*, Theobald; *B. moreletiana*, Nevill; *Hydrobioides nana*, Annandale; *H. avarix*, Annandale.

To *Salaria*, gen. nov.:—

Bithynia evezardi, Blanford, the only known species.

To *Mysorella*, Godwin-Austen:—

Bithynia costigera (Küster) with its race *curta*, Nevill, which is the type of the genus.

All these species occur within the limits of the Indian Empire, but *B. tentaculata* and *B. troscheli* are Palaearctic and are only found, so far as India is concerned, in Kashmir and the neighbouring country, while *Hydrobioides* seems to be exclusively Burmese; *Mysorella* is confined to the southern part of Peninsular India (plains and Mysore Plateau) and Ceylon, and *Salaria* to the Bombay section of the Western Ghats. The range of *Alocinma* extends from Mesopotamia to Upper Burma, and the south of the Indian Peninsula, but the subgenus is closely allied to the Palaearctic *Pseudamnicola*, which may also be regarded as a subgenus of *Amnicola*. *Amnicola* (s.s.) is American. *Bithynia* is found all over Europe and Asia, but is perhaps mainly Palaearctic.

Subfamily BITHYNIINAE.

Genus *Amnicola*, Gould and Haldeman (1841).

1865. *Amnicola*, Simpson, *Smiths. Misc. Coll.* 201, p. 12.

This genus, as has been pointed out recently, can be divided into three subgenera, *Amnicola*, s.s. (American), *Pseudamnicola* (Palaearctic) and *Alocinma* (Indian, Persian and Mesopotamian). All the Indian species of the genus I have examined belong to it.

Subgenus *Alocinma*, Annand. and Prashad (1919).

1919. *Alocinma*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 23.

The shells of this subgenus are more or less globose, with the whorls somewhat tumid, the body-whorl very large and the suture rather wide. The umbilicus is almost or entirely closed and the columellar fold is never prominent though always ridge-like. There is no well-defined groove proceeding downwards from the umbilicus outside the fold. The shell-sculpture is microscopic. The

structure of the operculum is distinctive when it can be seen, but is often obscured by deposits of algae or mineral substances on the surface. These should always be cleared away before the operculum is examined. It fits precisely into the mouth of the shell. The radula differs from that of *Bithynia* in the following points:— (1) the central tooth has a distinct quadrate projection on its disc and is produced in the middle on the basal margin; (2) the latero-basal denticulations on this tooth are very few and are situated at some distance from the lateral margins; (3) none of the denticulations of the lateral teeth are greatly enlarged; (4) those of both marginals are minute and sharp. The soft parts seem to be very similar in the two genera.

TYPE-SPECIES, *Amnicola sistonica*, Annandale and Prashad.

Mousson's¹ *Bithynia ejecta* from Mesopotamia belongs to this subgenus, as well as the type-species and the Indian and Burmese forms listed above.

Genus *Bithynia*, Leach (1818).

1919. *Bithynia*, Godwin-Austen, *Rec. Ind. Mus.* XVI, p. 213.

The shell of this genus is as a rule more elongate, more acuminate and more conical than that of *Amnicola*. The umbilicus is usually perforate but constricted and even when it is completely closed a well-defined groove can be distinguished proceeding obliquely downwards from it but not meeting the margin of the lip. The columellar fold is a sharp and prominent ridge, forming a wall along the inner margin of the groove. The shell-sculpture in the Indian forms is microscopic. The operculum is never very thick. It is marked externally with coarse concentric ridges, encircling a central or subcentral nucleus. The internal surface is nearly smooth. In young specimens traces of a spiral structure can sometimes be detected on the external surface. The radula differs from that of *Alocinma* in the points noted in discussing the latter genus.

TYPE-SPECIES, *Helix tentaculata*, Linné.

Hydrobioides, Blanford (1869).

1918. *Hydrobioides*, Annandale, *Rec. Ind. Mus.* XIV, p. 117.

This genus is closely related to *Bithynia* but may be distinguished by the structure of the lower part of the shell and of the radula. Although the spire and the upper part of the body-whorl are thin the lower part of the latter, or rather the lower and outer part, is considerably thickened and has a more or less porcellaneous appearance. The columellar callus is also much broader and flatter. In several species a prominent varix on the body-whorl is a conspicuous feature. The shell varies in shape so greatly that two subgenera may be distinguished. The operculum is like that of *Bithynia*, but is relatively smaller² and the concentric lines

¹ Mousson, *Fourn. Conchyl.* XXII, p. 46 (1874).

² It is sometimes withdrawn into the shell in highly contracted specimens.

penetrate to the internal surface. The radula closely resembles that of *Alocinma*; but the laterals have the central denticulation much enlarged and bear a distinct prominence on their disc.

The two subgenera may be distinguished as follows:—

1. Shell more or less elongate, acuminate, with the main axis of the spire and that of the body-whorl in the same straight line and the mouth vertical .. *Hydrobioides* (s.s.)
2. Shell globose, with the spire short and oblique, almost neritiform, with the mouth very oblique ... *Paranerita*, nov.

The type-species of *Hydrobioides* (s.s.) is *Bithynia turrita*, Blandford; that of *Paranerita*, *Hydrobioides phiscus*, Annandale, the only known species. I can find no structural difference between the animals of the two subgenera.

The peculiarities of the lower part of the shell in both subgenera seem to be correlated with a very definite, probably seasonal and recurring period of arrested growth. The varix in those species in which it persists represents the last period of rest, after which there is apparently only one more growth-period. In several shells in Nevill's series of his *Bithynia moreletiana*, which must be referred to this genus, a well-defined varix is present at some distance from the mouth, but beyond this point the shell is very thin and the outer lip is sharp, proving that the animals were killed during a period of active growth.

The porcellaneous appearance of the mouth and the outlines of the shell give the species of *Hydrobioides* (s.s.) a superficial resemblance to those of *Pachydrobia*, Crosse and Fischer, an Indo-Chinese genus; but the structure of the operculum is very different and the male organ of *Pachydrobia* differs in being simple and without a lateral process. The shell of *H. (Paranerita) phiscus*, on the other hand, resembles that of *Julliena* of the same authors and from the same region, but here again there are the same structural differences in the animal.

Genus *Sataria*, nov.

The shell is moderately small and thick, almost trochiform, with swollen whorls. The umbilicus is patent but not deep and is approached from the anterior border of the mouth by a broad, deep, oblique groove. The peristome is continuous, uniformly thickened internally, prominent and produced to a point both above and below. The sculpture of the shell consists of fine but distinct spiral grooves. The operculum is calcareous, of ovate outline and rather smaller than the mouth of the shell. The operculum is stout and marked with strong concentric ridges externally, the nucleus being central; internally it is convex and without sculpture. The radula resembles that of *Bithynia* but the denticulations of the teeth are blunter and there is a quadrate process on the disc of the central tooth. Nothing is known of the soft parts.

The only known species is Blanford's *Bithynia evezardi*¹ from Mahableshwar in the Satara district and Khandalla in the Poona district of the Bombay Presidency. Both places are situated at moderate altitudes in the Western Ghats and the range of the genus seems to be coterminous with that of the remarkable Littorinid genus *Cremnoconchus*, Blanford, which lives in the spray of waterfalls. Nothing is known of the habits of *Sataria* and very few specimens have been collected.

Subfamily *MYSORELLINAE*, nov.

Genus *Mysorella*, Godwin-Austen (1919).

1919. *Mysoria*, Godwin-Austen, *Rec. Ind. Mus.* XVI, p. 211.

1919. *Mysorella*, *id. ibid.*, p. 431.

1919. *Mysoria*, Annandale, *Rec. Geol. Surv. Ind.* L, p. 211.

In describing this genus (under the name *Mysoria*) Col. Godwin-Austen drew attention to the remarkable difference between its radula and that of *Bithynia* and suggested that they might be placed in different families. The external anatomy, however, is so similar in the two genera that this course seems unnecessary, and the recognition of a special subfamily will meet the case, unless some conspicuous difference can be found in the internal anatomy. The original name, which was preoccupied in Insecta, was subsequently changed to *Mysorella*.

TYPE-SPECIES, *Paludina costigera*, Küster.

Two local races are distinguished, the typical form from the southern part of the Madras Presidency and Ceylon and the var. *curta*, Nevill² from the Mysore plateau. The former is a mollusc of the plains and is common in the neighbourhood of the town of Madras, while the latter has been found only at an elevation of about 3,000 feet above sea-level.

It is noteworthy that while the shell has a very close external resemblance to that of the Littorinid *Cremnoconchus syhadrensis* (Bfd.) and both genera are highly modified, their habits are quite unlike. *Cremnoconchus* lives on vertical rocks kept wet by the spray of waterfalls, while *Mysorella* frequents the edge of ponds and flooded rice-fields. In the latter it burrows into the mud when desiccation takes place, and it is completely aquatic. The shorter-shelled form (*curta*) is found among stones, while the *forma typica* usually frequents a muddy bottom.

¹ See Blanford, *Fourn. As. Soc. Bengal* XLIX (2), p. 220; Nevill, *ibid.*, XLX (2), p. 157, pl. vi, fig. 13.

² Nevill, *Hand List Moll. Ind. Mus.* II, p. 42 (1884).